FEB 1957
LIBRARY
POFI
FISH & WILDLIFE
SERVICE

PERIODICAL
Calif. (Dept. of Fish & Game.)
Fish Bull.
No. 50-59
1937-44

DATE	ISSUED TO
JAN 1 1 1962	Yoshida
MAY 8 1962	[illegible]
NOV 15 1963	Ushida
11-3-65	[illegible]
4/21/66	[illegible]
2-13-68	[illegible]
6/14/7	[illegible]
1/9	[illegible]
4/	[illegible]

PERIODICAL
Calif. (Dept. of Fish & Game)
Fish Bulletin
No. 50 - 59
1937-44

LIBRARY
BUR. OF COMM. FISH.
HON. BIOL. LAB.

DIVISION OF FISH AND GAME OF CALIFORNIA
BUREAU OF MARINE FISHERIES

FISH BULLETIN No. 50

1953 60

Sizes of California Sardines Caught in the Different Areas of the Monterey and San Pedro Regions

By J. B. PHILLIPS
CALIFORNIA STATE FISHERIES LABORATORY

46326

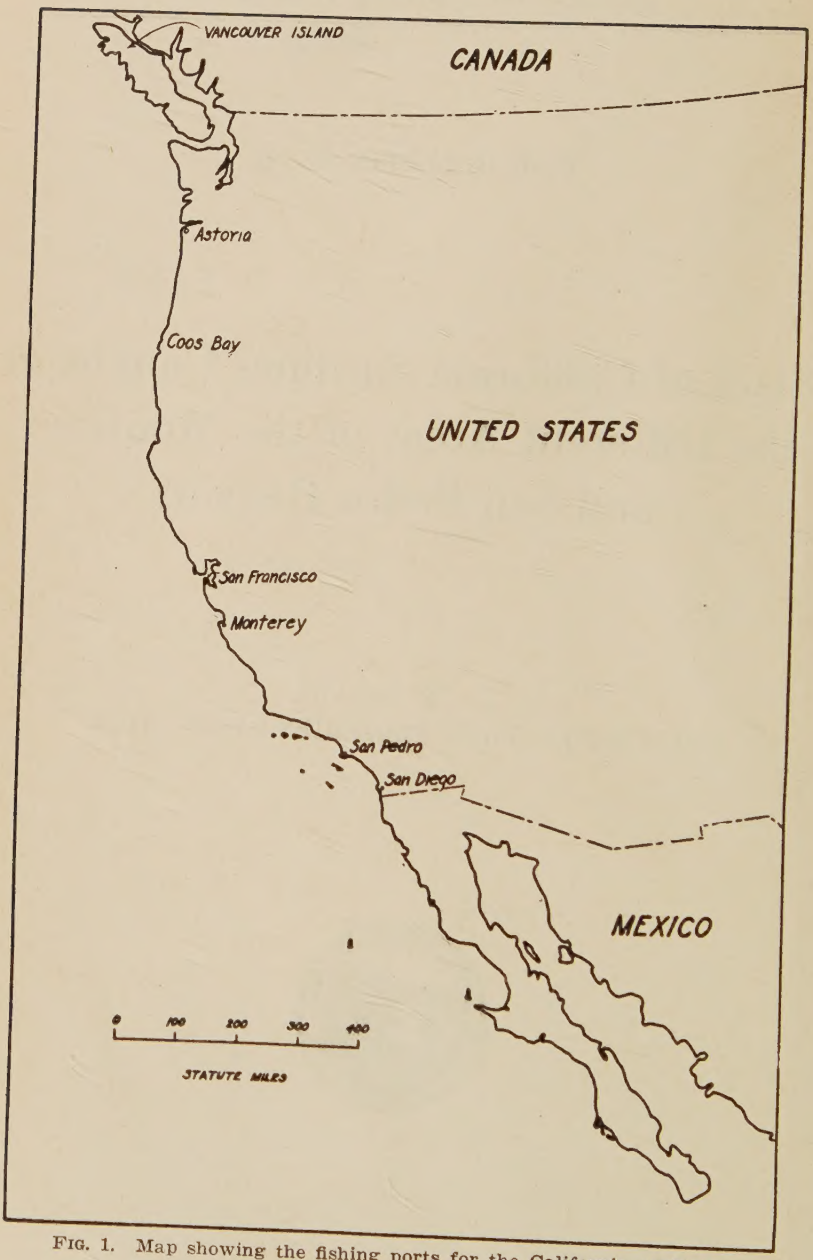

FIG. 1. Map showing the fishing ports for the California sardine.

CONTENTS

	Page
Introduction	5
Fishing regions along the California coast for the sardine	5
Factors that influence the sizes of sardines caught	6
Methods	7
Source of data	7
Treatment of data	7
The sizes of sardines caught in the different areas of the Monterey region	9
Introduction	9
Division into fishing areas	9
Lunar month averages of sardines for the entire Monterey region	9
Monthly averages of sardines from the different areas of the Monterey region	11
Summary	17
The sizes of sardines caught in the different areas of the San Pedro region	19
Introduction	19
Division into fishing areas	19
Lunar month averages of sardines for the entire San Pedro region	19
Monthly averages of sardines from the different areas of the San Pedro region	19
Sizes of sardines in the different sections of the mainland area of the San Pedro region	26
Summary	30
Conclusion	30
Literature cited	31

2—46326

Digitized by the Internet Archive
in 2025

https://archive.org/details/california-fish-bulletin_1937_50

SIZES OF CALIFORNIA SARDINES CAUGHT IN THE DIFFERENT AREAS OF THE MONTEREY AND SAN PEDRO REGIONS[1]

By J. B. Phillips, California State Fisheries Laboratory

INTRODUCTION

This paper deals with the sizes of California sardines (*Sardinops caerulea*)[2] caught in the different areas of the Monterey and San Pedro regions off the coast of California. The present report is a sequel to Fish Bulletin 43, "The sizes of California sardines caught by the different fishing gear and in the different localities of the Monterey and San Pedro regions," except that in the present report no further work dealing with the sizes of sardines caught by different fishing gear was found necessary. The data of five more seasons have been added, allowing more definite conclusions, particularly for the Monterey region, where the data for only two seasons were available for the previous work. Also, a new fishing area has been added to the Monterey region.

This report is concerned only with the fishery as carried on in connection with the canning and reduction of sardines and does not include the fishery for the fresh fish and bait industry. The former phase is the more important and the one for which we have continuous sampling data.

The results of this investigation are of importance to cannery and reduction plant operators and to us, in showing the sizes of fish that can be expected in the different areas during an average season. Also additional evidence is furnished that indicates a southward movement of sardines along the California coast during the winter months.

The findings for the Monterey region tend to have more bearing on the sampling of sardines than do the findings for the San Pedro region. During the fall months there are significant size differences between sardines in the southern and northern areas of the Monterey region, whereas in the San Pedro region consistent size differences between sardines in the different areas are not present. Therefore, during a season when the fishery might be carried on for the most part in the northern areas of the Monterey region, we will have larger size-groups represented than during a season in which the fishery might be carried on for the most part in the southern areas.

FISHING REGIONS ALONG THE CALIFORNIA COAST FOR THE SARDINE

Fishing for sardines for the canneries and reduction plants along the California coast is carried on in four regions—San Diego, San Pedro, Monterey and San Francisco. Up to the 1935-36 season, the

[1] Submitted for publication, February 1, 1937.

[2] Since September, 1935, the California State Fisheries Laboratory has adopted the generally accepted generic name of *Sardinops* in place of *Sardina* to designate the California sardine. The specific name *caerulea* is retained.

San Pedro and Monterey regions have been the most important. During recent years, San Diego ceased to be of any great importance as a sardine port, whereas the San Francisco district has been gaining continuously.

In southern California the San Diego and San Pedro fishing grounds overlap to a limited extent. In the San Diego region, in general however, sardine fishing is carried on between Del Mar, about 20 miles[3] north of San Diego, and Descanso Point, about 25 miles south of San Diego. In the San Pedro region, the sardine fishermen operate between Santa Barbara and San Miguel Island on the north and Oceanside and the south end of San Clemente Island on the south. Similarly in northern California, the San Francisco and Monterey fishermen fish the same grounds with fair frequency. In the Monterey region, sardine fishing occurs between Pt. Reyes, 115 miles north of Monterey and Pfeiffer Pt., 28 miles south of Monterey. In the San Francisco region, sardine fishing is carried on between Pt. Reyes, about 30 miles northwesterly of San Francisco, and Pigeon Pt., about 40 miles to the southward. The northern portion of what has been termed the Monterey region, therefore, coincides with the San Francisco region. In other words, boats from the San Francisco district and the Monterey district fish in the same region, their activities overlapping at times. If sardine fishing in the San Francisco region continues to develop at the same rate as during the 1935-36 season, it would be appropriate to recognize these two regions jointly as the San Francisco-Monterey region. However, in the present paper, any data including the San Francisco region are classified under the Monterey region because the bulk of the data for the San Francisco region, except for the 1935-36 season, has been from sampling records obtained at Monterey. The San Diego region being of little importance is not treated in this paper.

FACTORS THAT INFLUENCE THE SIZES OF SARDINES CAUGHT

The following factors have been known to influence the sizes of sardines caught:

1. Sardines average larger during the light of the moon than during the dark of the moon. (Scofield, 1926)

2. Sardines taken in the early and in the last part of the night are larger than those caught during the middle of the night. (Scofield, 1926)

3. Small or medium sardines are taken by the commercial fishermen in the fall and large sardines are caught in the winter. (Clark, 1930.2)

4. Different dominant size-groups of sardines appearing in the commercial catch in various seasons influence the average sizes of sardines according to the size of the dominant year-group. (Clark, 1931)

In Fish Bulletin 43 and in the present paper, the possible influence of factors 1 and 2 has been reduced to a minimum by the use of no

[3] Land miles are referred to in this paper and not nautical miles. One nautical mile equals 1.15 land miles.

time interval smaller than the lunar month. Factor 3, regarding the taking of small or medium sized sardines by commercial fishermen in the fall and large sardines in the winter is an important item that is emphasized in the present paper. Since the main fishery for sardines for canning and reduction purposes in California exists only during the fall and winter months,[4] the other seasonal phases are not considered. The effect of dominant size-groups of sardines on the sizes of fish in the catch is minimized in this paper by the use of averages for several seasons.

METHODS

Source of Data

The material for this study has been obtained from sampling data gathered by the California State Fisheries Laboratory. It represents standard or body length measurements in millimeters of representative samples taken at random from the catch. This material is on file at the California State Fisheries Laboratory, Terminal Island, California.

For the past number of years, the sardine catch has been sampled semi-weekly at Monterey and San Pedro. Each half week, samples of fifty fish each are taken at random from the catches of five different boats. At the same time, the captain or a representative of the crew of that particular fishing boat is questioned as to the location of catch, number of hauls made, the time of each haul, the amount taken each haul, and the tonnage limit set by the plant for that boat. The name of the boat, type of gear used and the name of the cannery to which the fish are delivered are also secured. No attempt is made to sample any particular type of gear, or fish taken in any particular locality within the fishing region. The plan has always been to make the sampling as representative as possible of the cannery and reduction catch.

Two measurements are taken, in millimeters, for each fish of a sample—body length and total length. The body length is taken from the tip of the jaw, with mouth closed, to the termination of skin at the base of the caudal fin (tail). The total length is from the tip of the jaw to the tip of the lower edge of the caudal fin, held parallel to the longitudinal axis of the body. The body length measurement is more reliable and the one upon which our work is based; the total length serves only as a check.

Treatment of Data

This paper is divided into two parts—the Monterey region and the San Pedro region. The treatment of the data is the same for the different areas of both regions.

The average or mean length of fish is used as the basis for comparing the sizes of sardines from the different areas. Length frequency curves are included where comparisons are made of combined seasons. These combinations are here considered an average season for the

[4] Beginning with the 1929-30 season, a State law specified that, except for bait, fresh fish markets, smoking, drying or packing in square cans less than 10 ounces, sardines can be taken only during the period August 1-February 15, north of the mouth of the Carmel River (this applies to the Monterey and San Francisco regions); and during the period November 1-April 1, south of the above point (this applies to the San Pedro and San Diego regions). Previous to this time, sardines could be taken at any time for canning in any sized cans.

period studied. The seasons included are the seven seasons, 1929-30 to 1935-36, inclusive. Seasons 1929-30 and 1930-31 were treated in Fish Bulletin 43, but are added here to give more data on which to base the average season summary.

The lunar month averages of sardines for the different areas were obtained by dividing the total body lengths of fish from each area by the total number of fish represented in that area.

Since the sardine fishing is carried on at night and almost entirely during the periods of dark between full moons, there is a natural division of the sampling data to correspond. Usually there are several days in which fishing ceases at the time of full moon because of the restricted dark.[5] We call these periods between full moons a lunar period or lunar month. The average lunar month is about 29 days and theoretically there are approximately twelve and one-third of these months in a calendar year. Therefore, lunar months and calendar months are not directly comparable, although for practical purposes similar lunar months for a number of seasons can be grouped together to represent a calendar month.

The term "average or normal season" as used in this paper designates the average size of sardines for each month that enters into the average season. To calculate these values for the period 1929-30 to 1935-36, similar lunar months of the different seasons were grouped together into corresponding calendar months. The average size of the sardines taken in each of these lunar months were again averaged for each grouping. This method of averaging assured an equal weighting for the data of each lunar month regardless of the number of fish involved. This procedure was necessary to eliminate the influence of dominant size-groups.

The average frequency curves for the different areas, by approximate calendar months, were obtained by combining the percentages of fish at each millimeter of length for similar lunar months, during the period 1929-30 to 1935-36, smoothing twice by three's and then dividing for an average.

Data are not available for all areas for all lunar months. In fact, at San Pedro an area may not be represented for an entire season. The data for the Pt. Sur area of the Monterey region are so restricted that no comparison was possible in the present paper.

The Pt. Sur area was first represented in our sampling data during the 1933-34 season. It was represented again during the 1934-35 season but not in 1935-36. In the 1933-34 and 1934-35 seasons this area was represented for only one semi-weekly period during one of the winter months. Fishermen are reluctant to fish southward of Monterey Bay to Pt. Sur because of the extensive rockiness of the coast and because disorderly currents present here interfere with netting operations. This restricts fishing to some distance off-shore, except to the southward of Pt. Sur. Therefore, this area is only fished as a last resort, when fishermen have little success to the northward of Monterey.

[5] Locating schools of sardines is made difficult when there is daylight or strong moonlight because the luminescence created by the schools when near the surface can not be detected. There are occasions during daylight or strong moonlight when sardines are observed flipping at the surface, but such occurrences are not depended upon by fishermen because the size and the compactness of the schools can not be determined.

THE SIZES OF SARDINES CAUGHT IN THE DIFFERENT AREAS OF THE MONTEREY REGION

Introduction

Until the 1924-25 sardine season, practically all catches of sardines in the Monterey region were made in and off Monterey Bay. Between 1924-25 and 1929-30, the northern limit of the fishing grounds was gradually extended to Halfmoon Bay. During 1929-30, the northern limit was extended to Pt. Reyes. In 1933-34, the Monterey region was enlarged southward to Pfeiffer Pt.

Division into Fishing Areas

For this study, the Monterey region was divided into five areas. (See Fig. 2.) From north to south, the boundaries of these areas are:

San Francisco area, including waters between a line due west of Pt. Reyes and south to a line due west of the city of South San Francisco (about 11 miles south of Fort Pt.).

Halfmoon Bay area, including waters south of the San Francisco area to a line due west of a point half way between Pillar Pt. and Pigeon Pt.

Pigeon Pt. area, including waters south of the Halfmoon Bay area to a line due west of Pt. Santa Cruz.

Monterey Bay area, including waters south of the Pigeon Pt. area to a line due west of Pt. Pinos.

Pt. Sur area, including the waters south of the Monterey Bay area to a line due west of a point three miles south of Pfeiffer Pt.

The first four areas have practically the same boundaries as areas I-IV described in Fish Bulletin 43.

Lunar Month Averages of Sardines for the Entire Monterey Region

Table 1 gives the average body lengths of sardines from the entire Monterey region by lunar months and the corresponding calendar months for the seven seasons, 1929-30 to 1935-36, inclusive. The average for the seven seasons is also shown. Figure 3 is drawn from the data in table 1 and covers the period August-February, the average season in the Monterey region for the above period.

It is evident that during a normal season, there is little variation in average size of sardines in the fishery from August to October. In November, the average size of sardines commences to increase and there is a continued gradual increase during the balance of the season, until the last month of the season finds sardines of the largest average size present in the region.

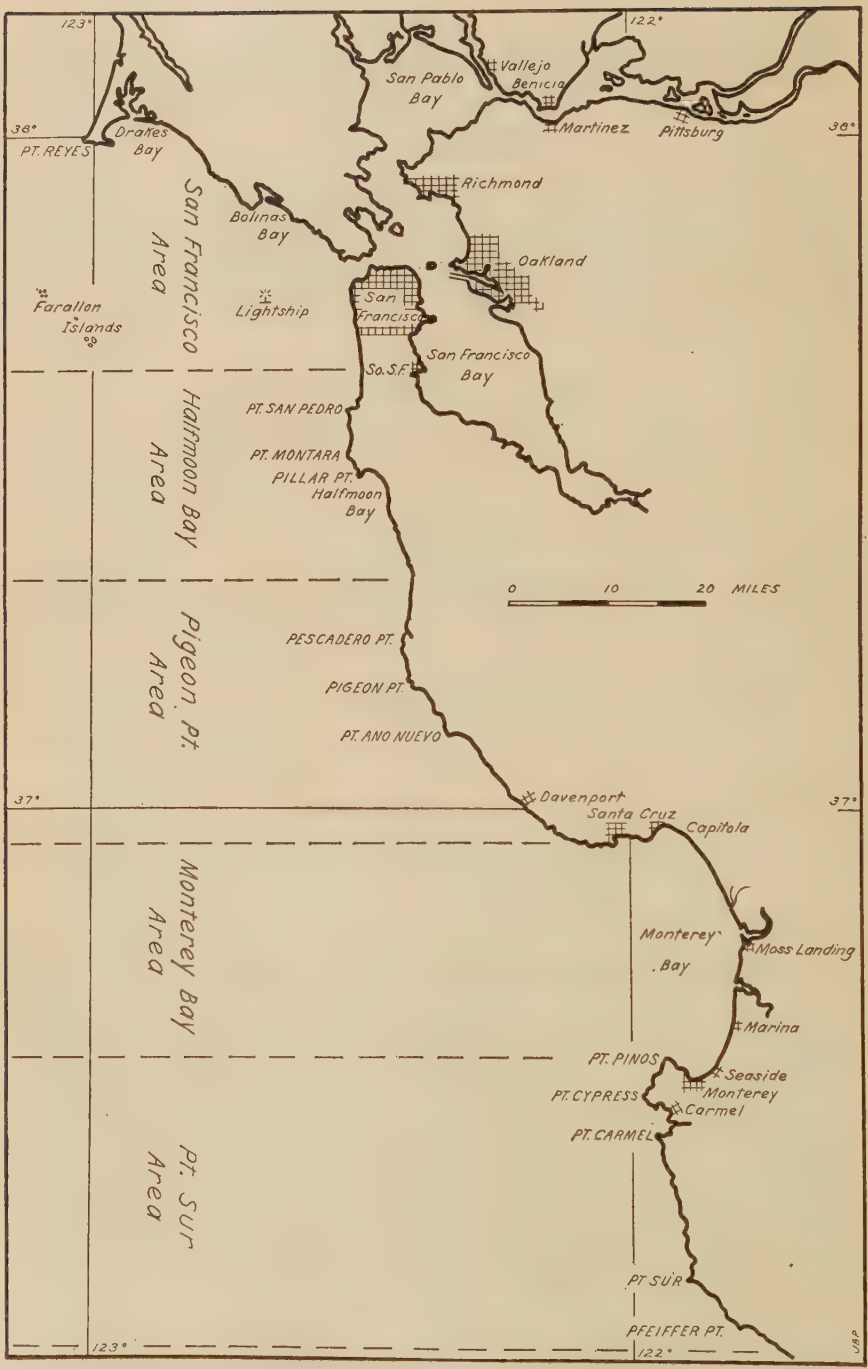

FIG. 2. Map of fishing areas covered by fishing boats supplying the Monterey sardine plants. Sardine plants in the San Francisco district are supplied by boats working mainly in the San Francisco and Halfmoon Bay areas.

TABLE 1

Average Lengths in Millimeters of Sardines From the Entire Monterey Region by Lunar Months and the Corresponding Calendar Months for Seven Seasons, 1929-30 to 1935-36, Inclusive. Also, the Average of the Seven Seasons

Approximate calendar month	1929-1930			1930-1931			1931-1932		
	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length
August	121	1,000	205.6	134	1,750	213.4	146	1,000	207.2
September	122	1,750	212.7	135	1,500	213.6	147	2,000	212.6
October	123	1,500	216.8	136	2,000	211.0	148	1,750	213.8
November	124	1,500	218.1	137	1,750	214.5	149	1,750	212.1
December	125	1,250	217.6	138	1,750	218.1	150	1,250	217.1
January	126	1,500	218.1	139	1,250	226.5	151	1,500	229.1
February	127	1,750	236.7	140	1,000	232.9	152	1,750	241.6

Approximate calendar month	1932-1933			1933-1934			1934-1935		
	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length
August	159	1,750	221.6	171	1,750	221.8	183	1,250	217.2
September	160	2,000	219.7	172	1,000	221.6	184	2,000	217.1
October	161	1,500	221.3	173	1,000	216.4	185	1,750	218.0
November	162	1,250	230.3	174	1,750	225.9	186	1,500	212.5
December	163	1,750	234.7	175	1,500	235.0	187	1,750	224.5
January	164	1,250	245.4	176	1,750	239.3	188	1,250	231.9
February	165	500	244.3	177	1,250	244.3	189	2,000	239.8

Approximate calendar months	1935-1936			Seasons combined	
	Lunar month	Number of fish	Average body length	Number of fish	Average body length
August	195	750	214.0	9,250	214.4
September	196	1,500	214.1	11,750	215.9
October	197	2,000	213.4	11,500	215.8
November	198	2,000	216.8	11,500	218.6
December	199	1,500	224.3	10,750	224.5
January	200	1,750	218.5	10,250	229.8
February	201	1,500	233.6	9,750	239.0

Monthly Averages of Sardines from the Different Areas of the Monterey Region

In table 2 are given the average body lengths of sardines by lunar months for the different areas of the Monterey region from 1929-30 to 1935-36. Figure 4 is drawn from the data in table 2 and covers comparable lunar months for the period August to February. It can be noted that there is a tendency for the average sizes to vary but little during the fall months and to show a steady increase during the winter months.

In order to smooth over seasonal differences and thereby obtain a clearer picture for a period of years, the data of table 2 were summed into an average season by combining similar lunar months during the above period. These combined data are shown in table 3 and figure

TABLE 2

Average Lengths in Millimeters of Sardines by Lunar Months and the Corresponding Calendar Months in the Different Areas of the Monterey Region, by Seasons, 1929-30 to 1935-36, Inclusive

Approximate calendar month	Lunar month	San Francisco Area		Halfmoon Bay Area		Pigeon Point Area		Monterey Bay Area		Point Sur Area	
		Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length
1929-1930—											
August	121							1,000	205.6		
September	122					200	208.1	1,550	213.3		
October	123					100	215.1	1,400	216.9		
November	124					100	222.2	1,400	217.8		
December	125	50	232.4	200	222.3	250	223.1	750	213.6		
January	126	150	224.7	450	229.5	50	239.2	850	209.7		
February	127			550	236.7	150	238.6	1,050	236.5		
1930-1931—											
	133							500	203.1		
August	134							1,750	213.4		
September	135					100	202.4	1,400	214.4		
October	136	50	218.6	50	210.8	200	211.3	1,700	210.7		
November	137	100	215.3	500	215.3	600	215.5	500	212.4		
December	138	200	224.4	350	219.2	1,050	216.6	150	217.5		
January	139	150	230.1	50	239.6	400	226.2	650	224.8		
February	140					400	233.0	600	232.9		
1931-1932—											
August	146					250	204.1	750	208.3		
September	147			50	212.1	1,550	212.1	400	214.7		
October	148	150	219.4	150	209.8	850	213.2	600	214.3		
November	149	150	219.3	350	214.8	450	207.6	800	212.1		
December	150	250	229.0	200	211.0	200	223.0	600	214.0		
January	151	200	232.4	100	226.0	900	226.5	250	236.9		
February	152	50	243.1	300	245.1	400	240.8	850	240.6		
1932-1933—											
August	159	50	231.6	300	212.8	550	222.5	850	223.6		
September	160			450	222.5	1,000	219.9	450	215.9		
October	161	50	232.0	100	228.9	600	221.4	750	219.6		
November	162	200	233.3	750	231.2	300	226.1				
December	163			250	231.3	300	231.1	1,150	236.5		
January	164	150	249.0	450	246.2	450	244.1	150	242.9		
February	165					100	241.9	400	244.9		
1933-1934—											
August	171					200	234.1	1,550	220.2		
September	172	50	237.8	250	223.0	200	227.0	500	217.0		
October	173							1,000	216.4		
November	174			150	227.3	650	225.2	900	225.7		
December	175	50	248.5	450	237.6	150	228.8	750	234.4		
January	176	200	239.9	450	239.8	400	236.8	550	242.4	150	232.4
February	177			50	245.5	100	245.2	1,100	244.2		
1934-1935—											
August	183					50	232.3	1,150	216.6		
September	184			50	219.8			1,950	217.0		
October	185			*400	221.6	200	212.4	1,450	218.7		
November	186	*500	232.3			550	209.9	950	214.0		
December	187	*300	244.4	200	217.7	750	227.4	650	223.2		
January	188			*350	233.0	150	238.9	800	230.8		
February	189			300	240.3	200	248.1	1,050	241.9	350	226.4
1935-1936—											
August	195					400	216.7	350	211.0		
September	196			50	218.5	600	215.1	850	213.1		
October	197	*900	218.0	*1,000	220.3	500	216.8	1,500	212.3		
November	198	*700	229.1	*850	223.7	650	218.3	1,050	215.0		
December	199	*1,000	239.5	*1,500	227.8	500	223.7	300	218.7		
January	200	*100	230.9	*900	229.2	800	222.8	400	210.9		
February	201	*800	236.7	*700	238.3	550	234.9	750	231.3		
	202							500	234.0		

* Includes samples taken at San Francisco.

TABLE 3

Average of the Combined Average Lengths of Sardines for the Seven Seasons, 1929-30 to 1935-36, Inclusive, for the Different Areas of the Monterey Region

Approximate calendar month	San Francisco Area		Halfmoon Bay Area		Pigeon Point Area		Monterey Bay Area		Point Sur Area	
	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length
August	*1	231.6	*1	212.8	5	221.9	7	214.1		
September	*1	237.8	5	219.2	6	214.1	7	215.1		
October	4	222.0	5	218.3	6	215.0	7	215.6		
November	5	225.9	5	222.5	7	217.8	6	216.2		
December	6	236.4	7	223.8	7	224.8	7	222.6		
January	6	234.5	7	234.8	7	233.5	7	228.3	*1	232.4
February	2	239.9	5	241.2	7	240.4	7	238.9	*1	226.4

* Too few lunar months to be representative.

5. For figure 5, the data were plotted only for months that were represented by at least two seasons.

Frequency curves showing the average percentage of sardines at different lengths in the different areas, covering the 1929-30 to 1935-36 period, by months are shown in figure 6. The average lengths shown in table 3 and figure 5 are derived from the same data as the frequency curves in figure 6.

In table 3 and figures 5 and 6, during August only the Monterey Bay and the Pigeon Pt. areas are represented by adequate data. In September the Halfmoon Bay area and in October the San Francisco area also become represented adequately. The only months in which comparisons can be made with all four areas are October to February.

The monthly average sizes of fish as given in table 3 and figure 5 show that at the start of the season the average size of Pigeon Pt. fish, 222 mm. body length or 10.3 in. total length, is noticeably greater

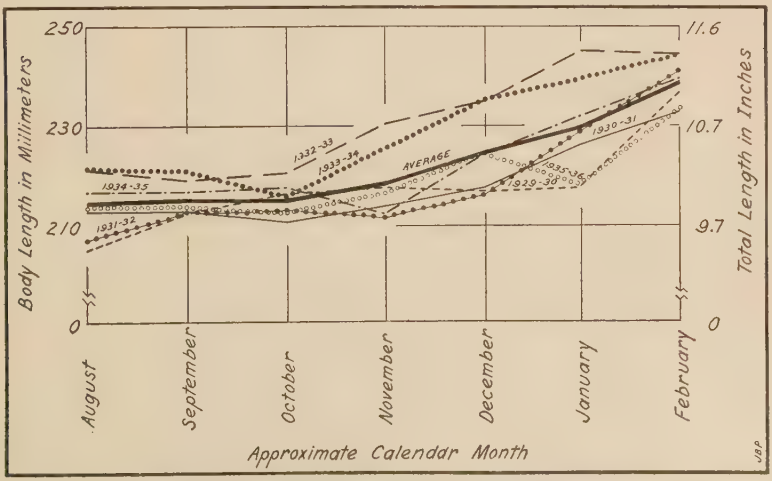

FIG. 3. Average lengths of sardines from the entire Monterey region by approximate calendar months for seven seasons, 1929-30 to 1935-36, inclusive. Also, the average of the seven seasons.

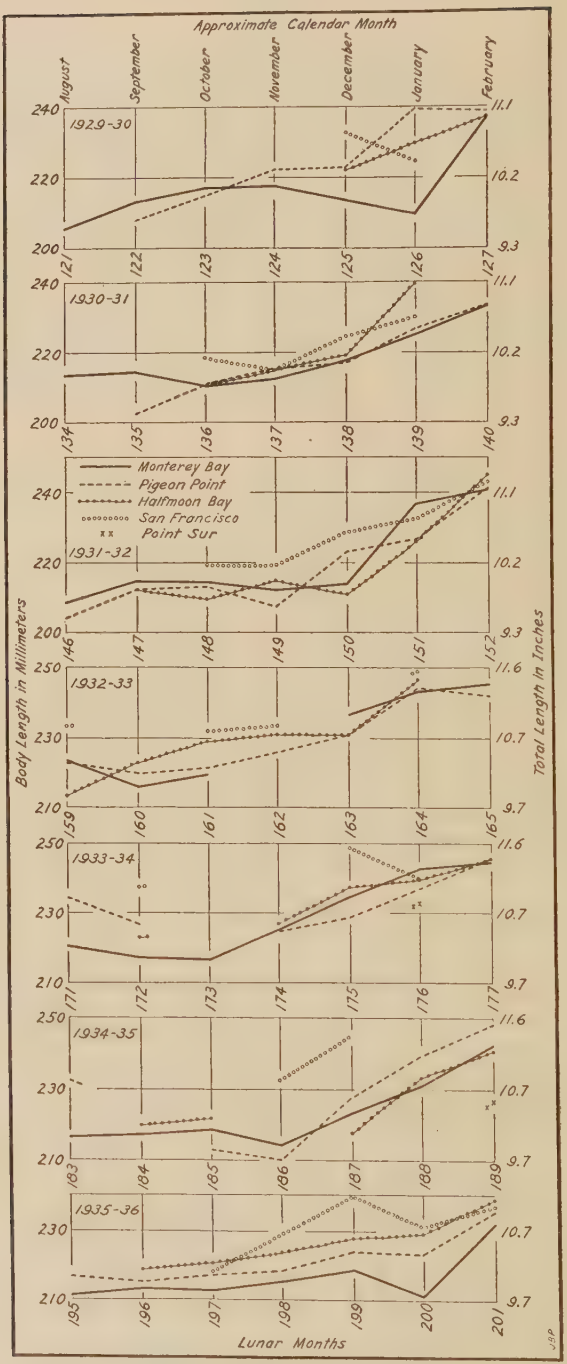

FIG. 4. Average lengths of sardines by lunar months and the corresponding calendar months in the different areas of the Monterey region by seasons, 1929-30 to 1935-36, inclusive.

than the average size of the Monterey Bay fish, 214 mm. body length or 9.9 in. total length. In September, the average size of the sardines in the Pigeon Pt. area dropped to approximately the same size as those of the Monterey Bay area, that is, 214 and 215 mm. body length or 9.9 in. total length. The Halfmoon Bay fish that appeared in the sampling during this month averaged 219 mm. body length or 10.1 in. total length. In October, fish of smallest average size occurred in both the Monterey Bay and Pigeon Pt. areas. These fish were 215 and 216 mm. body length or 10.0 in. total length. The Halfmoon Bay fish averaged larger in size, 218 mm. body length or 10.1 in. total length, whereas the San Francisco fish that appeared in the sampling during this month averaged largest, 222 mm. body length or 10.3 in. total length. During November, the fish of smallest average size were found in the Monterey Bay area; fish of next largest average size were in the Pigeon Pt. area; next came the Halfmoon Bay area; and fish of largest average size occurred in the San Francisco area. The average sizes of the fish in these four areas, during this month, were 216 to 223 mm. body length or 10.0 to 10.3 in. total length. In December the average size of the fish in the Monterey Bay, Pigeon Pt. and Halfmoon Bay areas was 223 to 225 mm. body length or 10.3 to 10.4 in. total length. On the other hand, the San Francisco area fish averaged considerably larger, 236 mm. body length or 10.9 in. total length. During January, the fish of smallest average size were again found in the Monterey Bay area, whereas the fish in the Pigeon Pt., Halfmoon Bay and San Francisco areas averaged approximately the same size, 234 to 235 mm. body length or 10.8 in. total length. In February, the last month of the season, the average sizes of the fish in all areas were nearly the same, varying between 239 and 241 mm. body length or 11.0 to 11.1 in. total length.

Figure 6 shows the average size frequencies, that is, the distribution of sizes, for the seven season period of which figure 5 shows only the average lengths. The outstanding feature of the frequency curves in figure 6 is the sudden increase in the San Francisco area during

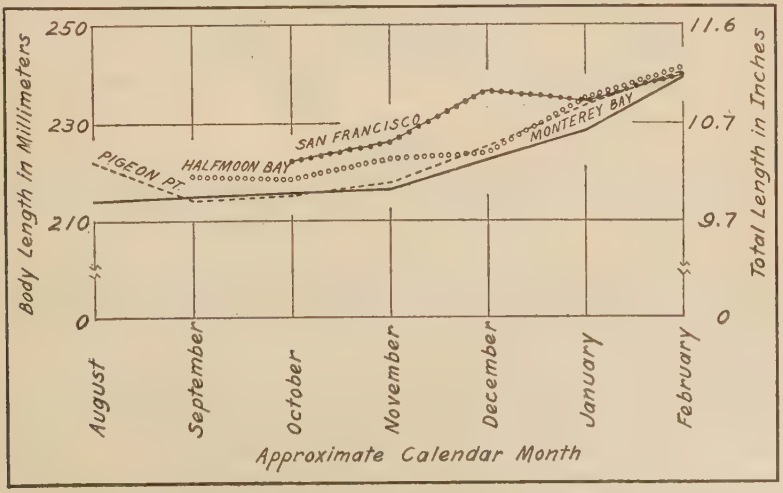

FIG. 5. Average of seven seasons, 1929-30 to 1935-36, inclusive, of average lengths of sardines from the different areas of the Monterey region by approximate calendar months.

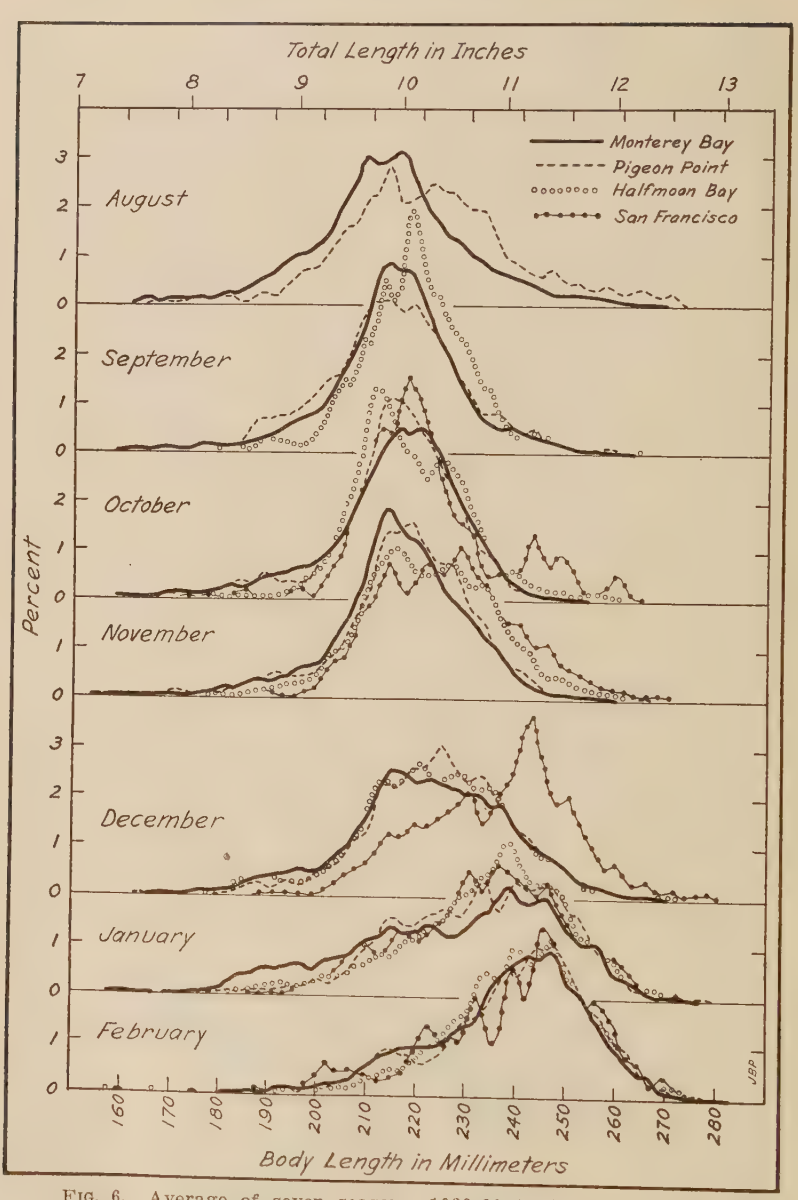

FIG. 6. Average of seven seasons, 1929-30 to 1935-36, inclusive, frequency curves of sardines from the different areas of the Monterey region by approximate calendar months.

December in the proportion of large fish with a mode of about 243 mm. body length or 11.2 in. total length. These larger fish appear to have come from the northward as only traces of such large fish are present to the southward (including the San Pedro region) up to this time. Even in October and November, the San Francisco area had more of these larger fish than any of the other areas. During January and February, the bulk of the fish in all areas were made up of larger

fish, with the largest amounts for all areas occurring in February, the last month of the season.

TABLE 4

Monthly Percentages of Sardines, 230 mm. and More in Body Length, for the Combined Seasons, 1929-30 to 1935-36, Inclusive, for the Different Areas of the Monterey Region

Approximate calendar month	San Francisco Area Per cent	Halfmoon Bay Area Per cent	Pigeon Point Area Per cent	Monterey Bay Area Per cent
August			30.0	15.4
September		16.3	12.5	11.4
October	22.2	15.5	9.9	12.3
November	38.8	30.2	17.7	15.0
December	67.8	37.0	37.4	34.5
January	65.6	67.9	61.5	53.9
February	76.1	81.4	78.5	75.2

To determine definitely the month in which the bulk, that is over 50 per cent, of the fish of each area is composed of larger sizes, table 4 was compiled, which shows the monthly percentage of sardines 230 mm. and more in body length (collectively termed "winter fish" or "winter fishery" in this paper), for the combined seasons 1929-30 to 1935-36. These data were compiled from the same calculations from which the frequency curves in figure 6 were drawn. Table 4 indicates that the "winter fish" first made up the majority of the catch in the San Francisco area during December. In January, the bulk of the fish in all areas were "winter fish." The area with the smallest percentage is Monterey Bay, and the area with the largest percentage is Halfmoon Bay. The percentage for the San Francisco area had dropped somewhat from the preceding month and was slightly less than that for the Halfmoon Bay area at this time. In February, all areas showed increases in the percentage of "winter fish" present, but again with the smallest percentage in the Monterey Bay area and the highest percentage in the Halfmoon Bay area. It appears from the foregoing that the "winter fish" first occur in bulk quantity in the San Francisco area in December and in succeeding months move southward. During January and February, the percentage of "winter fish" entering the San Francisco area lessens. In February, the percentage of "winter fish" in all areas tends to become equal.

Summary

This study of the sizes of sardines in the different areas of the Monterey region, covering the period 1929-30 to 1935-36, inclusive, has furnished the following results:

During the fall months of August to November, fish of smallest average size were found equally in both the Monterey Bay and Pigeon Pt. areas, fish of a larger average size in the Halfmoon Bay area, and fish of largest average size in the San Francisco area.

The average sizes in all areas showed immaterial increases during the fall fishery and considerable increases during the winter fishery (December to February), due to an influx of larger fish, termed "winter fish."

The "winter fish" are first present in bulk proportions in the San Francisco area in December and thence in other areas of the Monterey region during the succeeding month.

FIG. 7. Map of the San Pedro region showing the three areas in which sardine boats fish. The four sections of the mainland area are also shown.

THE SIZES OF SARDINES CAUGHT IN THE DIFFERENT AREAS OF THE SAN PEDRO REGION

Introduction

Up to and including 1924, practically all catches of sardines in the San Pedro region were made in waters close to the mainland and not far from Los Angeles Harbor. In 1925 the area fished was enlarged to include the northern Channel Islands. Just prior to 1927, the fishing grounds were enlarged farther to include the southern islands. There has been no additional enlargement of the San Pedro fishing grounds since 1927.

Division into Fishing Areas

For this study, the San Pedro region was divided into three areas as shown in figure 7. The areas and their boundaries are:

Mainland area, from Oceanside on the south to 5 miles beyond Pt. Dume on the north, including the waters out to Santa Catalina Island.

Northern islands area, includes the waters from a point 5 miles northwesterly of Pt. Dume, southward to a line due west of Pt. Vicente from longitude 119°, and northward to Pt. Conception. This includes the waters around Anacapa, Santa Cruz, Santa Rosa and San Miguel islands.

Southern islands area, comprises the waters outside the other two areas. This includes the waters around San Clemente, San Nicolas and Santa Barbara islands, and outside Santa Catalina Island.

The above areas have practically the same boundaries as those in Fish Bulletin 43, except that the line between the mainland and northern islands areas has been moved five miles northwesterly of Pt. Dume instead of directly off that point. In Fish Bulletin 43 the catches off Pt. Dume were thrown into the mainland area so that the present analysis is comparable.

Lunar Month Averages of Sardines for the Entire San Pedro Region

Table 5 gives the average body lengths of sardines from the entire San Pedro region by lunar months and the corresponding calendar months for the seven seasons 1929-30 to 1935-36, inclusive. The average of these seven seasons is also shown. Figure 8 was drawn from the data in table 5, covering the period from November to March, the normal fishing season in the San Pedro region.

It will be noted that during a normal season, the average size of sardines increases gradually from November to January. In February, there is a marked increase in average size, and a lesser increase in March at which time the largest fish of the season are present.

Monthly Averages of Sardines from the Different Areas of the San Pedro Region

In table 6 and figure 9 are given the average body lengths of sardines by lunar months for the different areas of the San Pedro region, 1929-30 to 1935-36, inclusive. The general tendency is for the

average size of the fish in the different areas to increase during a season. However, it is also evident that the data are not adequate for all areas except for three of the seven seasons. During the three seasons in which there is sufficient representation for all areas, 1929-30, 1931-32 and 1932-33, the tendency toward an increase in average size throughout a season is evident, but there is no indication that any one of the three areas consistently had larger or smaller average sized fish.

TABLE 5

Average Body Lengths in Millimeters of Sardines from the Entire San Pedro Region by Lunar Months, and the Corresponding Calendar Months, for Seven Seasons, 1929-30 to 1935-36, Inclusive. Also, the Average of the Seven Seasons

Approximate calendar month	1929-1930			1930-1931			1931-1932		
	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length
October	124	875	196.6						
November	125	2,000	200.4	137	1,250	202.4	149	1,000	219.9
December	126	1,500	205.9	138	1,200	206.3	150	1,500	214.2
January	127	2,000	216.1	139	1,700	212.3	151	1,250	216.4
February	128	1,500	228.7	140	1,500	236.9	152	1,500	225.3
March	129	1,250	241.4	141	1,500	238.1	153	1,000	232.8

Approximate calendar month	1932-1933			1933-1934			1934-1935		
	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length	Lunar month	Number of fish	Average body length
October	161	1,000	220.5						
November	162	2,000	221.4	174	1,500	205.1	186	1,250	214.5
December	163	1,750	224.6	175	2,000	224.5	187	1,750	214.7
January	164	1,600	226.4	176	1,750	216.0	188	1,500	219.7
February	165	2,000	235.8	177	2,000	240.1	189	2,000	225.8
March	166	1,500	236.6	178	1,500	238.6	190	1,750	236.6
April							191	500	204.8

Approximate calendar month	1935-1936			Seasons combined	
	Lunar month	Number of fish	Average body length	Number of fish	Average body length
October	198	500	212.5	2,375	209.8
November	199	1,750	210.0	10,750	210.5
December	200	1,500	205.6	11,200	213.7
January	201	1,750	221.9	11,550	218.4
February	202	1,500	235.3	12,000	232.6
March	203	1,750	235.1	10,250	237.0
April				500	204.8

In order to smooth over seasonal differences and thereby obtain a more normal condition for a period of years, the data of table 6 were summed into an average season by combining similar lunar months during the period 1929-30 to 1935-36. These data are shown in table 7 and figure 10. Frequency curves showing, for different areas, the average percentage of sardines at different lengths, covering

the period 1929-30 to 1935-36 by months, are shown in figure 11. The average lengths shown in table 7 and figure 10 were derived from the same set of data as the frequency curves shown in figure 11.

TABLE 6

Average Body Lengths in Millimeters of Sardines by Lunar Months, in the Different Areas of the San Pedro Region, 1929-30 to 1935-36, Inclusive

Lunar month	Northern Islands Area		Mainland Area		Southern Islands Area	
	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length
1929-1930—						
124	200	192.5	675	197.8		
125	850	199.1	500	200.3	700	202.0
126	750	206.7	500	205.1	250	205.5
127	750	207.4	966	222.9	284	216.1
128	300	231.5	1,050	228.8	150	222.5
129	250	243.5	700	243.0	300	236.0
1930-1931—						
137	975	202.7			150	200.4
138	750	207.9			450	203.7
139	113	221.8			1,587	211.6
140					1,500	236.9
141	100	238.8	300	237.5	1,100	238.2
1931-1932—						
149	50	217.1			950	220.0
150	100	212.6			1,400	214.3
151			450	216.1	700	217.4
152	50	232.9	250	224.8	1,100	224.0
153	50	242.8	350	238.4	550	228.4
1932-1933—						
161	675	220.7			325	220.0
162	500	220.9	550	220.7	900	222.1
163	350	220.8	1,000	225.5	400	225.8
164	200	230.6	1,300	225.1	100	234.0
165	400	236.7	1,150	237.7	450	230.1
166	125	233.2	1,375	236.9		
1933-1934—						
174	400	200.1	750	207.8	250	210.4
175			1,300	226.5	700	221.0
176			1,500	217.6	150	203.7
177			2,000	240.1		
178			1,500	238.6		
1934-1935—						
186	150	210.3	1,100	215.0		
187	200	225.1	1,550	213.4		
188	200	218.7	1,300	219.9		
189			2,000	225.8		
190	50	217.4	1,700	237.2		
191			500	204.8		
1935-1936—						
198	250	211.6	250	213.4		
199	1,000	210.2	750	209.7		
200	700	204.9	750	205.8		
201			1,750	221.9		
202			1,500	235.3		
203			1,750	235.1		

Table 7 and figures 10 and 11 indicate that during the "fall fishery" (November-January),[6] for an average season, the average sizes of the fish in the three areas increased gradually from November through January. In February, there was a marked increase in average size in all three areas, and a further less marked increase in March, the last month of the season. At this time the average sizes were largest for all three areas.

[6] The term "fall fish" or "fall fishery" here is used to designate general size of fish and not season of the year.

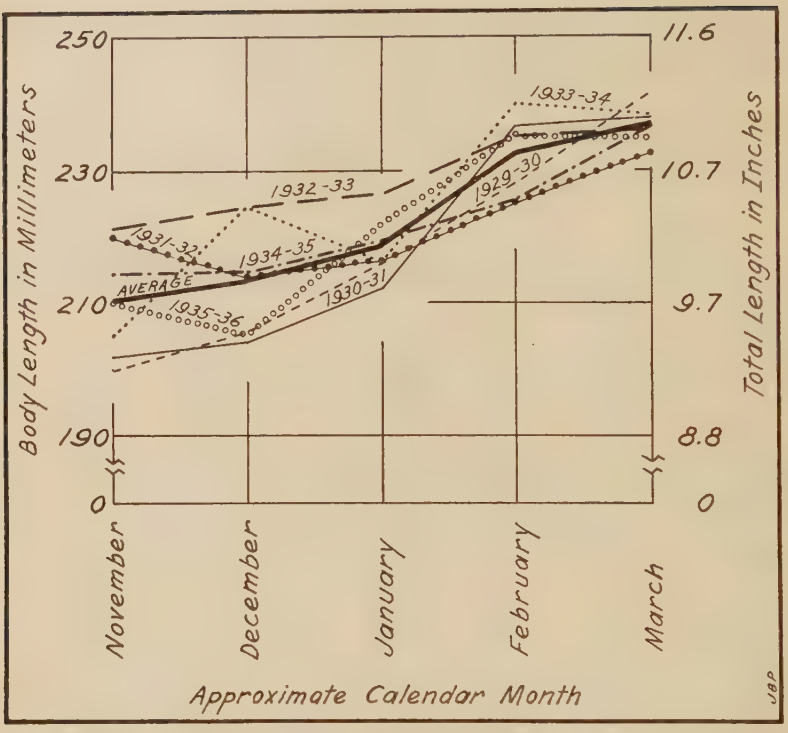

FIG. 8. Average lengths of sardines from the entire San Pedro region by approximate calendar months for seven seasons, 1929-30 to 1935-36, inclusive. Also, the average of the seven seasons.

TABLE 7

Average of the Combined Average Lengths of Sardines for the Seven Seasons, 1929-30 to 1935-36, Inclusive, for the Different Areas of the San Pedro Region

Approximate calendar month	Northern Islands Area		Mainland Area		Southern Islands Area	
	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length
November	7	208.6	5	210.7	5	211.0
December	6	213.0	5	215.3	5	214.1
January	4	219.6	6	220.6	5	216.6
February	3	233.7	6	232.1	4	228.4
March	5	235.1	7	238.1	3	234.2

Following through the monthly average sizes of fish as shown in table 7 and figure 10, it can be noted that at the start of the season in November, fish of smallest average size, 209 mm. body length or 9.6 in. total length, were found in the northern islands area, whereas the fish in the southern islands and mainland areas were of nearly equal size, 211 mm. body length or 9.8 in. total length. In December, all areas showed moderate increases but a slightly greater increase occurred in the northern islands area, and the smallest increase in the southern islands area. Nevertheless, the northern islands area was still slightly

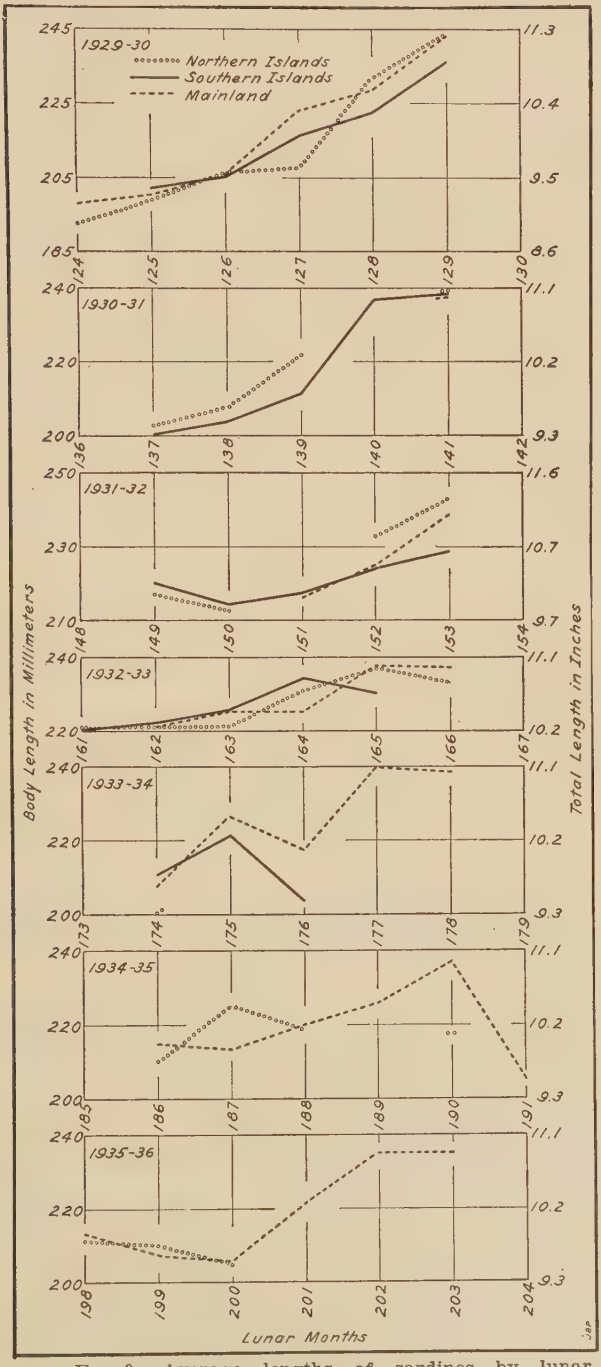

FIG. 9. Average lengths of sardines by lunar months in the different areas of the San Pedro region by seasons, 1929-30 to 1935-36, inclusive.

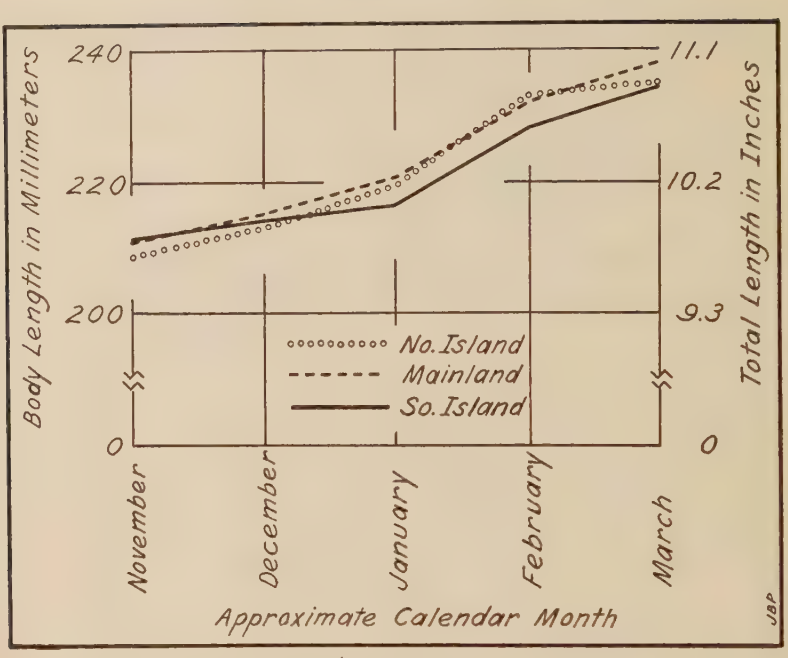

Fig. 10. Average of seven seasons, 1929-30 to 1935-36, inclusive, of average lengths of sardines from the different areas of the San Pedro region by approximate calendar months.

below the other two areas. In January, all areas again showed moderate increases but the northern islands fish once more showed the greater increase with an average size now equalling that of the mainland. At this time the average size of the fish in the mainland and northern islands areas were 220 to 221 mm. body length or 10.2 in. total length, and the southern islands area 217 mm. or 10.0 in. total length. In February, the month during which there was the greatest increase in the average size of fish in all areas, the northern islands again showed the greater increase and the average size exceeded the other two areas but was only slightly greater than the mainland. The average sizes of the fish during February were: northern islands, 234 mm. body length or 10.8 in. total length; mainland, 232 mm. body length or 10.7 in. total length; southern islands, 228 mm. body length or 10.5 in. total length. In March, the mainland and the southern islands evinced similar moderate increases, and the northern islands showed only a slight increase with an average size of the fish almost identical with that of the southern islands. Fish of the largest average size were found in the mainland area. At this time the average size of the mainland fish was 238 mm. body length or 11.0 in. total length, and the northern islands and southern islands fish 234 to 235 mm. or 10.8 to 10.9 in. total length.

To supplement a further analysis on sizes of fish, figure 11 is given. This figure shows the average size frequencies, that is, the

distribution of sizes for the seven season period, of which figure 10 presents only the average lengths.

The frequency curves in figure 11 indicate that there is a moderate tendency toward an increase in the numbers of larger fish from November through January. This is in keeping with the increases of average sizes shown in figure 10. As suggested in figure 10, the greatest increase in the numbers of distinctly larger sized fish in all areas came during the month of February. Of these areas, the northern islands area showed the highest percentage of these distinctly larger fish during this month. During March there was a further increase in the percentage of these larger fish.

Table 8 furnishes a check on the above observations. In this table are given the monthly percentage of sardines, 230 mm. and more in body length (collectively termed "winter fish" or "winter fishery" for this paper) for the combined seasons 1929-30 to 1935-36 for the three areas of the San Pedro region. These data were compiled from the same data from which the frequency curves in figure 11 were drawn. Table 8 indicates that although there was an increasing percentage of the larger fish in all areas throughout the season, the first month in

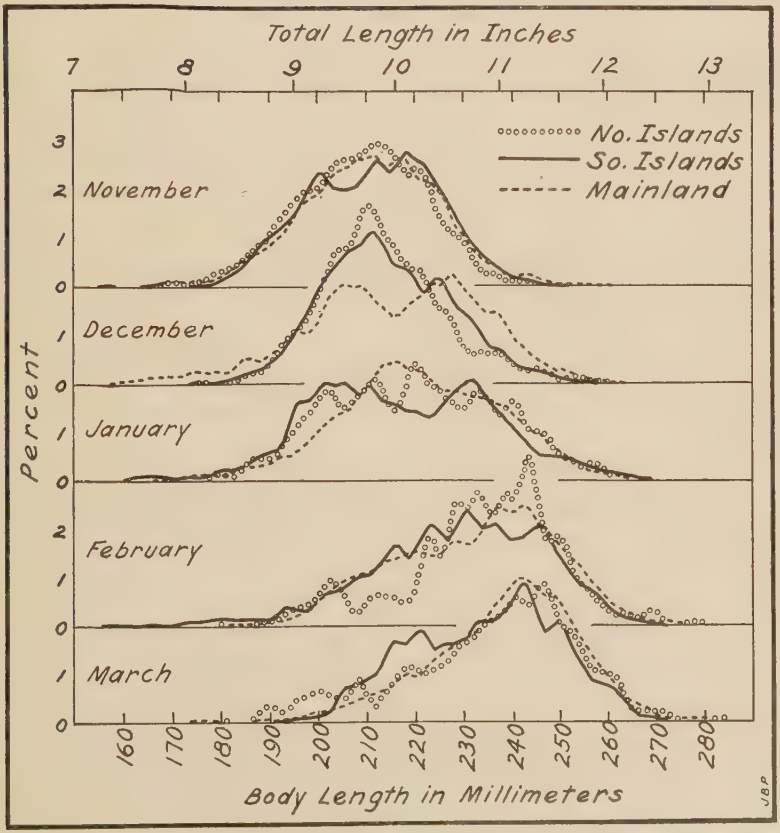

FIG. 11. Average of seven seasons, 1929-30 to 1935-36, inclusive, frequency curves of sardines from the different areas of the San Pedro region by approximate calendar months.

which the greatest increase occurred and the bulk of the fish were "winter fish," was February. During this month, the area that had the largest percentage of these "winter fish" was the northern islands area, with the mainland area next. In March, there were further increases in the percentage of the "winter fish" in all areas, with the mainland area having the greatest amount and the northern islands next.

TABLE 8

Monthly Percentages of Sardines, 230 mm. and More in Body Length, for the Combined Seasons, 1929-30 to 1935-36, Inclusive, for the Different Areas of the San Pedro Region

Approximate calendar month	Northern Islands Area Per cent	Mainland Area Per cent	Southern Islands Area Per cent
November	4.7	8.4	8.5
December	10.5	24.4	13.3
January	31.3	31.1	28.7
February	66.0	59.0	51.7
March	68.1	73.9	62.4

Sizes of Sardines in the Different Sections of the Mainland Area of the San Pedro Region

The mainland area of the San Pedro region was divided into four sections to determine if any one locality harbored larger fish than any other.

The boundaries of the four sections of the mainland area (northwestward to southeastward, see figure 7) are as follows:

Pt. Dume, from the boundary of the northern islands and mainland areas to a line paralleling this boundary, beginning halfway between the cities of Santa Monica and Venice.

Pt. Vicente, from the Pt. Dume section to a line halfway between the cities of Long Beach and Newport and out to the southeastern tip of Santa Catalina Island.

Newport, from the Pt. Vicente section to a line starting at Pt. San Juan and paralleling the Pt. Vicente section.

Oceanside, the remaining portion of the mainland section to the southeastward.

In table 9 are given the number and average sizes of sardines for the four sections of the mainland area for each lunar month of seasons 1929-30 to 1935-36, inclusive. This is the same period as that covered by the analysis of the San Pedro and Monterey regions by areas. In table 10 and figure 12 are given the average of the average body lengths of sardines for the same period by calendar months corresponding to similar lunar months, November to March, inclusive.

Table 10 and figure 12 show that the average sizes of fish in the Pt. Vicente and the Newport areas are very similar throughout an average season. During the "fall fishery" the largest fish were found in the Pt. Dume section and the smallest fish in the Oceanside section, with the Pt. Vicente and the Newport sections intermediate. During February, the first month when the bulk of the fish in all areas of the San Pedro region were "winter fish," the largest fish were found in the Newport section with slightly smaller fish in the Pt. Vicente section. The Pt. Dume fish are noticeably smaller in average size than

the other sections at this time, in fact, there is a slight dropping off in size from the previous month. In March, all sections showed increases in average sizes with the Pt. Vicente and Newport sections having equal and largest averages and the Pt. Dume and Oceanside sections having equal and smallest averages.

TABLE 9

Average Body Lengths in Millimeters of Sardines by Lunar Months, in the Different Sections of the Mainland Area of the San Pedro Region, for the Seasons, 1929-30 to 1935-36, Inclusive

Lunar month	Pt. Dume section		Pt. Vicente section		Newport section		Oceanside section	
	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length
1929-1930—								
124	363	193.2	250	193.1	62	243.8		
125	250	204.5	200	194.6	50	201.7		
126	150	202.9	300	208.4	50	191.8		
127	150	239.7	650	216.7	166	232.2		
128	250	226.8	625	227.2	175	237.5		
129	100	237.7	600	243.9				
1930-1931—								
137								
138								
139								
140								
141	50	231.5			250	238.7		
1931-1932—								
149								
150								
151			450	216.1				
152			250	224.8				
153			350	238.4				
1932-1933—								
162	250	226.1	300	216.2				
163			900	225.5	100	225.7		
164			800	226.5	500	223.1		
165	150	236.7	800	239.7	200	230.2		
166			1,191	236.9	184	237.2		
1933-1934—								
174	400	210.0	300	207.5	50	192.1		
175	450	225.4	600	227.8	250	225.1		
176	200	214.6	1,200	218.4	100	214.0		
177			1,750	240.0	250	240.5		
178			1,500	238.6				
1934-1935—								
186	200	214.7	600	215.6	200	214.4		
187	600	219.5	650	207.7	300	213.7		
188	350	222.4	450	219.9	250	225.4	250	210.7
189	250	219.5	500	232.4	900	224.2	350	224.8
190	250	231.8	1,150	238.4	300	237.3		
191			500	204.8				
1935-1936—								
198	150	212.4	50	218.0	50	211.8		
199	300	207.8	350	209.9	100	215.3		
200			700	205.7			50	206.6
201	100	219.8	1,300	223.1	200	211.8	150	226.4
202	50	207.4	1,100	235.9	150	239.5	150	235.3
203	50	234.5	1,150	234.5	200	239.9	350	234.5

As the largest precentage of "winter fish" in February were in the northern islands area and next in the mainland area, it would be expected that the Pt. Dume section of the mainland area, being adjacent to the northern islands area, would have as large or larger fish than any of the other sections of the mainland area at this time. However, it is the Newport section which harbors fish of largest aver-

age size at this time with the Pt. Vicente section next. Even the more southerly Oceanside section has fish of larger average size than the Pt. Dume section at this time.

TABLE 10

Average of the Combined Average Lengths of Sardines for the Seven Seasons, 1929-30 to 1935-36, Inclusive, for the Different Sections of the Mainland Area of the San Pedro Region

Approximate calendar month	Pt. Dume section		Pt. Vicente section		Newport section		Oceanside section	
	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length
November	5	212.6	5	208.8	4	205.9		
December	3	215.9	5	215.0	4	214.1	1	206.6
January	4	224.1	6	220.1	5	221.3	2	218.6
February	4	222.6	6	233.3	5	234.4	2	230.0
March	4	233.9	6	238.5	4	238.3	1	234.5

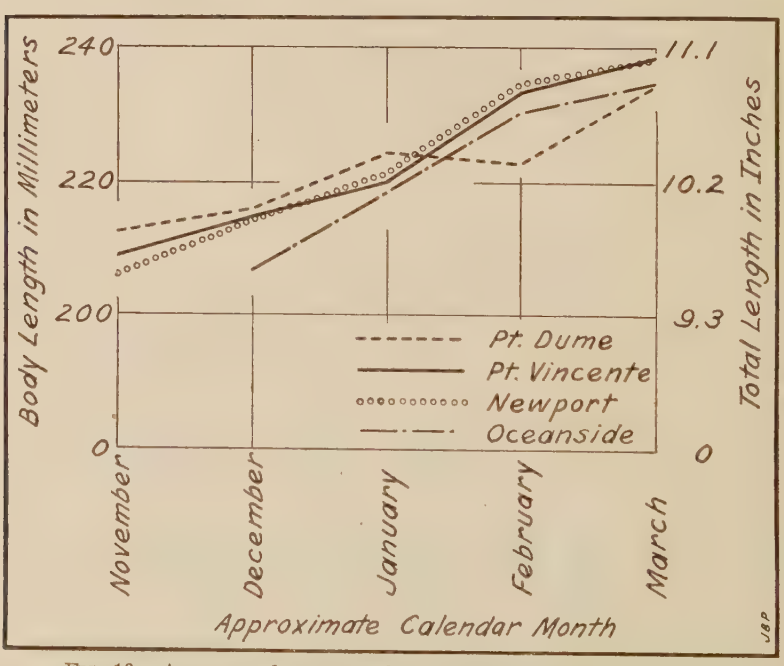

FIG. 12. Average of average body lengths of sardines, 1929-30 to 1935-36, inclusive, by calendar months corresponding to similar lunar months, for the different sections of the mainland area of the San Pedro region.

The following two tables, augmenting the data in tables 9 and 10, complete the material available for a study of the mainland area by sections. Table 11 gives the average body lengths of sardines by lunar months in the different sections of the mainland area of the San Pedro region for seasons 1925-26 to 1928-29, inclusive, as addendum to table 9. Table 12 (tables 9 and 11 combined) shows the average of the average body lengths of sardines for the period 1925-26

to 1935-36, inclusive, by calendar months corresponding to similar lunar months for the different sections.

TABLE 11

Average Body Lengths in Millimeters of Sardines by Lunar Months, in the Different Sections of the Mainland Area of the San Pedro Region, for the Seasons, 1925-26 to 1928-29, Inclusive

Lunar month	Pt. Dume section		Pt. Vicente section		Newport section		Oceanside section	
	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length	Number of fish	Average body length
1925-1926—								
74	250	208.4	1,050	207.8				
75	200	210.3	950	207.7				
76								
77	150	175.9	650	184.1	50	172.4		
78			1,100	216.0	750	235.6	50	239.8
79	50	209.7	900	221.9	450	230.9		
1926-1927—								
86			200	169.5				
87								
88								
89	250	216.0	350	218.5				
90	250	229.1	800	221.6	50	224.1		
91			750	236.7				
92	350	229.5	700	229.7	100	229.0		
93			1,000	236.4				
94			1,000	240.0				
1927-1928—								
100			750	216.6				
101	50	212.5	450	208.9	100	214.6		
102			1,375	220.3	150	204.3		
103			1,500	227.7				
104			1,700	231.3	400	231.6		
105			750	240.2	500	235.0		
106	150	235.0	100	237.3				
1928-1929—								
114			100	208.5				
115	150	233.3	433	209.9	317	197.8		
116	50	244.4	1,100	240.4	50	238.8		
117	375	241.1					125	235.8
118			750	228.4	500	229.3		

TABLE 12

Average o the Combined Average Lengths of Sardines for the Seasons, 1925-26 to 1928-29, Inclusive, for the Different Sections of the San Pedro Region

Approximate calendar month	Pt. Dume section		Pt. Vicente section		Newport section		Oceanside section	
	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length	Number of lunar months represented	Average body length
September	1	208.4	2	188.7				
October	3	205.3	4	208.9	2	227.8		
November	6	212.6	6	210.1	5	207.6		
December	5	207.9	9	211.8	6	205.5	1	206.6
January	6	226.5	10	219.6	8	220.5	3	225.6
February	6	224.1	10	233.0	8	234.2	2	230.0
March	6	234.4	8	237.6	6	236.2	2	235.2
April	2	219.9	4	226.7	1	229.3		
May			1	240.0				

In these augmented data, the average size of the fish in the Pt. Dume section during February showed a dropping off for the

eleven year average as it did for the seven year average. In fact, the comparable data for the November-March period covering the eleven year average (table 12) are practically the same as that covering the seven year average (table 10).

The results of the analysis of the mainland area by sections tend to emphasize the results of the San Pedro region by areas—when the winter fish reach southern California waters, there is a scattering throughout the region, as opposed to the more or less orderly progression southward found in the Monterey region.

Summary

This study of the sizes of sardines in the different areas of the San Pedro region, covering the period 1929-30 to 1935-36, inclusive, and the study of the sizes of sardines in the different sections of the mainland area, have yielded the following results:

In none of the three areas of the San Pedro region did the sardines average consistently larger during the average season.

The average sizes of sardines in all areas showed a gradual moderate increase during the fall fishery (November to January) and a considerable increase during the winter fishery (February to March), due to an influx of larger fish, termed "winter fish."

The first month in which the bulk of the fish in the San Pedro region consisted of "winter fish" was February. These "winter fish" tended to move into all areas at the same period but a slightly greater percentage appeared in the northern islands area. The progression was not orderly, from northward to southward, as was the tendency in the Monterey region but was rather a disarranged scattering.

An analysis of the four sections of the mainland area did not add any thing of significance to this study, except to emphasize that the "winter fish" appear to scatter upon reaching the San Pedro region.

CONCLUSION

During the fall fishery in the Monterey region, August to November, sardines of larger average size were found northward of Monterey Bay with the largest fish in the northern area (San Francisco), whereas, during the fall fishery in the San Pedro region, November to January, sardines did not average consistently larger in any particular area.

In all areas of both regions the average sizes of sardines increased considerably during the winter fishery (December to February in the Monterey region and February and March in the San Pedro region), due to an influx of larger fish, termed "winter fish."

The "winter fish" were first present in bulk proportions in the San Francisco area in December and thence in the other areas of the Monterey region during the succeeding month. It was not until February that the bulk of the fish in the San Pedro region were composed of "winter fish" and this occurred in all areas during the same period but with the percentage slightly greater in the northern islands area.

The evident southward movement of the "winter fish," which make their appearance first in the San Francisco area thence southward

into the Halfmoon Bay, Pigeon Pt. and Monterey Bay areas, coincides with other findings, indicating that there is an annual movement of the main body of adult California sardines along the coast toward a concentration in southern California waters for the purpose of spawning. The lack of any clear-cut indications of size differences in the various areas of the San Pedro region further suggests that this southward movement is halted in this region with a general dispersion of all sizes throughout the southern California waters. Facts shown by former studies, which indicated this southward movement, are the location of the central spawning grounds off southern California, between Pt. Conception and San Diego (Scofield, 1934); the ripening of the sex products at the time of the southward movement (Clark, 1934); and the consistent sequence in the size changes within each season of the Monterey and San Pedro fisheries, with the size increase occurring about one month later in the San Pedro than in the Monterey fishery (Clark, 1930 and 1936).

LITERATURE CITED

Clark, Frances N.

1930. 1. Fishing localities off San Pedro from 1919 to 1929 for the California sardine (*Sardina caerulea*). Calif. Div. Fish and Game, Fish Bull., No. 25, pp. 28-39.

1930. 2. Seasonal changes in the daily average length of the California sardine, *Sardina caerulea*. Calif. Div. Fish and Game, Fish Bull., No. 26, 20 pp.

1931. Dominant size-groups and their influence in the fishery for the California sardine (*Sardina caerulea*). Calif. Div. Fish and Game, Fish Bull., No. 31, pp. 7-42.

1934. Maturity of the California sardine (*Sardina caerulea*), determined by ova diameter measurements. Calif. Div. Fish and Game, Fish Bull., No. 42, 49 pp.

1935. A summary of the life history of the California sardine and its influence on the fishery. Calif. Fish and Game, vol. 21, pp. 1-9.

1936. Interseasonal and intraseasonal changes in size of the California sardine (*Sardinops caerulea*). Calif. Div. Fish and Game, Fish Bull., No. 47, 28 pp.

Clark, G. H.

1935. The effect of gear and locality on the sizes of sardines taken in the Los Angeles Harbor region. Calif. Div. Fish and Game, Fish Bull., No. 43, pp. 31-59.

Phillips, J. B.

1935. The sizes of sardines caught by the different fishing gear and in the different localities of the Monterey region. Calif. Div. Fish and Game, Fish Bull., No. 43, pp. 7-30.

Scofield, Eugene C.

1934. Early life history of the California sardine (*Sardina caerulea*), with special reference to distribution of eggs and larvae. Calif. Div. Fish and Game, Fish Bull., No. 41, 48 pp.

Scofield, W. L.

1926. The sardine at Monterey: Dominant size-classes and their progression, 1919-1923. Calif. Fish and Game Comm., Fish Bull., No. 11, pp. 191-221.

1929. Sardine fishing methods at Monterey, California. Calif. Div. Fish and Game, Fish Bull., No. 19, 61pp.

DIVISION OF FISH AND GAME OF CALIFORNIA
BUREAU OF MARINE FISHERIES

FISH BULLETINS

* No. 1. Report on Fish Conditions. 1913; 48 pp., 3 figs.

* No. 2. The Scientific Investigation of Marine Fisheries as Related to the Work of the Fish and Game Commission in Southern California. By Will F. Thompson. 1919; 27 pp., 4 figs.

* No. 3. The Spawning of the Grunion (*Leuresthes tenuis*). By Will F. Thompson, assisted by Julia Bell Thompson. 1919; 29 pp., 9 figs.

* No. 4. The Edible Clams, Mussels and Scallops of California. By Frank W. Weymouth. 1921; 74 pp., 19 pls., 26 figs.

* No. 5. A Key to the Families of Marine Fishes of the West Coast. By Edwin C. Starks. 1921; 16 pp., 4 figs.

* No. 6. A History of California Shore Whaling. By Edwin C. Starks. 1922; 38 pp., 22 figs.

* No. 7. The Life History and Growth of the Pismo Clam. By Frank W. Weymouth. 1923; 120 pp., 15 figs., 18 graphs.

* No. 8. Racial and Seasonal Variation in the Pacific Herring, California Sardine and California Anchovy. By Carl L. Hubbs. 1925; 23 pp., 4 pls.

* No. 9. Preliminary Investigation of the Purse Seine Industry of Southern California. By Tage Skogsberg. 1925; 95 pp., 23 figs.

* No. 10. The Life History of *Leuresthes tenuis*, an Atherine Fish with Tide Controlled Spawning Habits. By Frances N. Clark. 1925; 51 pp., 6 graphs, 7 pls.

* No. 11. The California Sardine. By the Staff of the California State Fisheries Laboratory. 1926; 221 pp., 74 figs.

No. 12. The Weight-Length Relationship of the California Sardine (*Sardina caerulea*) at San Pedro. By Frances N. Clark. 1928; 58 pp., 11 figs.

No. 13. The Seasonal Average Length Trends at Monterey of the California Sardine (*Sardina caerulea*). By Carroll B. Andrews. 1928; 13 pp., 6 figs.

* No. 14. Report on the Seals and Sea Lions of California. By Paul Bonnot. 1928; 61 pp., 38 figs.

* No. 15. The Commercial Fish Catch of California for the years 1926 and 1927. By the Bureau of Commercial Fisheries. 1929; 94 pp., 52 figs.

No. 16. The Life-History of the California Jack Smelt, *Atherinopsis californiensis*. By Frances N. Clark. 1929; 22 pp., 12 figs.

* No. 17. Sacramento-San Joaquin Salmon (*Oncorhynchus tschawytscha*) Fishery of California. By G. H. Clark. 1929; 73 pp., 32 figs.

No. 18. The Pismo Clam: Further Studies of its Life-History and depletion. By William C. Herrington. 1930; 67 pp., 16 figs.

No. 19. Sardine Fishing Methods at Monterey, California. By W. L. Scofield. 1929; 61 pp., 27 figs.

* Out of print.

* No. 20. The Commercial Fish Catch of California for the Year 1928. By the Staff of the Bureau of Commercial Fisheries. 1930; 109 pp., 62 figs.

* No. 21. Analysis of Boat Catches of White Sea Bass (*Cynoscion nobilis*) at San Pedro, California. By S. S. Whitehead. 1930; 26 pp., 20 figs.

No. 22. A Bibliography of the Tunas. By Genevieve Corwin. 1930; 103 pp.

No. 23. Success of the Purse Seine Boat in the Sardine Fishery at Monterey, California (1929-1930 Fishing Season). By J. B. Phillips. 1930; 28 pp., 19 figs.

No. 24. An Analysis of the Catch Statistics of the Striped Bass (*Roccus lineatus*) Fishery of California. By J. A. Craig. 1930; 41 pp., 22 figs.

No. 25. Fishing Areas Along the California Coast for the Sardine. (*Sardina caerulea*). By the California State Fisheries Laboratory. 1930; 44 pp., 25 figs.

No. 26. Seasonal Changes in the Daily Average Length of the California Sardine (*Sardina caerulea*). By Frances N. Clark. 1930; 22 pp., 11 figs.

No. 27. The Ring Net, Half Ring Net, or Purse Lampara in the Fisheries of California. By Donald H. Fry, Jr. 1930; 65 pp., 28 figs.

No. 28. Handbook of Common Commercial and Game Fishes of California. By Lionel A. Walford. 1931; 183 pp., 137 figs.

* No. 29. The Striped Bass of California. By Eugene C. Scofield. 1931; 82 pp., 46 figs.

* No. 30. The Commercial Fish Catch of California for the Year 1929. By the Staff of the Bureau of Commercial Fisheries. 1931; 133 pp., 75 figs.

No. 31. Studies of the Length Frequencies of the California Sardine (*Sardina caerulea*). By the California State Fisheries Laboratory. 1931; 53 pp., 24 figs.

No. 32. The California Halibut (*Paralichthys californicus*) and an Analysis of the Boat Catches. By G. H. Clark. 1931; 52 pp., 25 figs.

No. 33. Fishing Methods for the Bluefin Tuna (*Thunnus thynnus*) and an Analysis of the Catches. By S. S. Whitehead. 1931; 32 pp., 22 figs.

No. 34. Salmon of the Klamath River, California. By John O. Snyder. 1931; 130 pp., 44 figs.

No. 35. A Distributional List of the Species of Fresh Water Fishes Known to Occur in California. By Barton W. Evermann and Howard Walton Clark. 1931; 67 pp.

No. 36. A Bibliography of the Sardines. By Genevieve C. Wheeler. 1931; 133 pp.

No. 37. The California Barracuda (*Sphyraena argentea*). By Lionel A. Walford. 1932; 120 pp., 32 figs., 6 pls.

No. 38. The California Shrimp Industry. By Paul Bonnot. 1932; 20 pp., 11 figs.

No. 39. Fluctuations in the Abundance of Striped Bass (*Roccus lineatus*) in California. By G. H. Clark. 1933; 18 pp., 7 figs.

No. 40. The California Mackerel Fishery. By Richard S. Croker. 1933; 149 pp., 73 figs.

No. 41. Early Life-History of the California Sardine (*Sardina caerulea*), with Special Reference to Distribution of Eggs and Larvae. By Eugene C. Scofield. 1934; 48 pp., 24 figs.

No. 42. Maturity of the California Sardine (*Sardina caerulea*), Determined by Ova Diameter Measurements. By Frances N. Clark. 1934; 49 pp., 19 figs.

---

* Out of print.

Fish Bulletins

No. 43. The Sizes of California Sardines Caught by the Different Fishing Gear and in the Different Localities of the Monterey and San Pedro Regions. By the California State Fisheries Laboratory. 1934; 59 pp., 27 figs.

No. 44. The Commercial Fish Catch of California for the Years 1930–1934, Inclusive. By the Staff of the Bureau of Commercial Fisheries. 1935; 124 pp., 19 figs.

No. 45. The Sharks and Rays of California. By Lionel A. Walford. 1935; 66 pp., 58 figs.

No. 46. A Contribution toward the Life Histories of Two California Shrimps, *Crago franciscorum* (Stimpson) and *Crago nigricauda* (Stimpson). By Hugh R. Israel. 1935; 28 pp., 9 figs.

No. 47. Interseasonal and Intraseasonal Changes in Size of the California Sardine (*Sardinops caerulea*). By Frances N. Clark. 1936; 28 pp., 11 figs.

No. 48. Fishing Localities for the California Sardine, *Sardinops caerulea*, 1928-1936. By Frances N. Clark. 1937; 11 pp., 5 figs.

No. 49. The Commercial Fish Catch of California for the Year 1935. By the Bureau of Commercial Fisheries. 1937; 170 pp., 114 figs.

No. 50. Sizes of California Sardines Caught in the Different Areas of the Monterey and San Pedro Regions. By J. B. Phillips. 1937; 31 pp., 12 figs.

These bulletins are offered free of charge in exchange for the publications of other bodies engaged in marine research and to other interested persons at a nominal cost. Address: California State Fisheries Laboratory, Terminal Island, California.

o

46326 9-37 5M